

Introduction

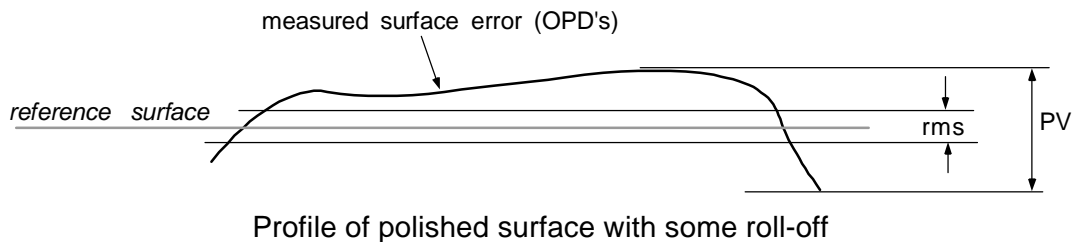
Many people are confused between the relationship of the peak-to-valley (PV) and root-mean-square (rms) results. This application note debunks the concept that PV and RMS have a fixed relationship and indicate general characteristics.

What's the difference between PV and RMS?

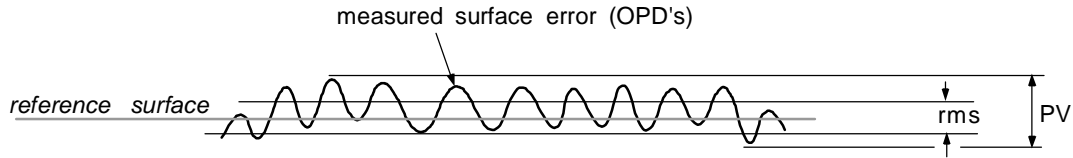
Peak-to-Valley error (PV) is a worst case error statistic. Calculation of the PV error uses only the high and low point on the surface relative to the reference surface. Since this only compares two points on the surface, it is possible for two very different surfaces to have the same PV error. The PV error does have the advantage that it is very easily estimated visually from the interferogram. It has the disadvantage that one small dig, or other artifact in the surface, can cause the PV to be very large even though the optic may perform quite well.

Root-mean-square error (rms) is an area weighted statistic. The rms is calculated as the standard deviation of the height (depth) of the test surface relative to the reference at all the data points in the interferogram. The rms has the advantage of more accurately reflecting the optical performance of the surface being measured.

There is no specific constant of proportionality relating the PV and rms errors. This ratio is dependent on the process used to generate the surface and the instrument used to measure the surface. Polished optical surfaces measured with a Zygo interferometer will typically show the PV error of the surface to be between a factor of 3 and 5 greater than the rms error. Surface with high spatial frequencies, such as diamond-turned surfaces, will generally show a smaller factor, in the range of 2 to 3. A very large ratio is often a sign that there are noisy data points in the measurement. It is recommended to examine a plot of the data to understand why the a high ratio is obtained. Cleaning and re-measuring the part may be advisable. The problem may also be fixed by properly focusing the interferometer on the part.



PV VERSUS RMS



Profile of diamond-turned surface with prominent feed marks

Note: Higher data sampling densities will show more of the surface detail. Be aware of the number of data points in any measurement, especially when comparing measurements of the same part made under different conditions. Expect differences in results (particularly the PV) when comparing such measurements. In particular, phase shifting systems (GPI-XP, Mark IV_{xp}, Mark IV, Mark III, ZyMod) will generally yield higher numbers than fringe analysis interferometers (GPI-ST/LC, Mark II, PTI, ZAPP, ZAPP/PC).